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Guest Editorial

Models and tools for integrated forest management and forest policy analysis: An Editorial☆

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ABSTRACT

Decision-making processes in the European Forest Sector are characterized by an enormous diversity in institutional and political framework conditions. In general, there is a clear need to improve policy integration and management approaches in order to deliver the competing ecosystem services demanded by society. The Special Issue "Models and tools for integrated forest management and forest policy analysis" originates from an initiative of Working Group 2 "Forestry modelling for integrated policy analysis" of COST Action FP1207 "Orchestrating forest-related policy analysis in Europe (ORCHESTRA)" to address this challenge. The emphasis is on improving the understanding and capacities in the use of forestry decision support tools for integrated policy analysis. For that purpose, it provides an overview of existing models, methods and/or decision support systems (DSS) that account or may be used for forest-related policy analysis at multiple levels. It discusses benefits and limitations/challenges of the use of these tools with a reference to its application in real case studies. Conclusions on the state-of-the-art in decision support for policy analysis and the needed advances in research are drawn.

1. Introduction

Decision-making processes in European forestry are characterized by an enormous diversity in institutional and political framework conditions. Although there is no common forest policy at the level of the European Union, a lot of interrelations and dependencies between local, subnational, national and supranational level exist. In addition to forest-focused policies, developed by forest authorities at different levels (e.g. European Forest Action Plan), forest-related policies covering issues such as biodiversity, climate change, and trade are playing an increasing role (e.g. EU Nature Directives, EU Biodiversity Strategy, EU Water Policy and EU Strategy on adaptation to Climate Change). In general, there is a clear need to improve policy integration and management approaches in order to deliver the competing ecosystem services demanded by society.

The use of management science methods as well as of decision support systems contributes to increase the efficiency and the effectiveness of decision-making processes. Its contribution to enhance forest management decision-making processes has been highlighted by Reynolds et al. (2008) and Borges et al. (2014a). Moreover, its potential for improving policy analysis and integration was underscored in the framework of the Minnesota Generic Environmental Impact Statement and the development of the State Sustainable Forest Resources Act in 1995 (Rose et al., 1993; Jaakko Poyry Consulting, 1994; Kilgore and Ek, 2007). As reported by Linkevičius et al. in this special issue, the opportunities for improving policy analysis and integration were recently further highlighted by the use of decision support tools to support policy backcasting processes in several case studies across Europe (e.g. Borges et al., 2017; Corrigan and Nieuwenhuis, 2016; Cintas et al., 2016; Eggers et al., 2015; Lämås et al., 2015; Orazio et al., 2017)

This Special issue explores the prospects for enhancing policy analysis decision-making processes by the use of a plethora of management science methods and decision support systems. It includes papers that report the use of simulation (e.g. Ray, Zengin et al.), network analysis (e.g., Lovrik et al.), behavior models and agent frameworks (e.g. Trubins et al. and Sotirov et al.), scenario analysis (e.g. Kavaliuskas et al., Mustapha et al. and Eggers et al.), discrete and continuous multiple criteria approaches (e.g. Huber et al., Alvarez-Miranda et al.) and decision systems (e. g. Nobre et al., Griess et al., Karkainen et al. and Athaniasiadis et al.), to support policy analysis and integration. It further includes a paper (Linkevicius et al.) that discusses the results of interviews to DSS developers and policy makers where they categorized key forest policy areas as well as the DS tools available to support them.

2. Simulation and scenario analysis

Simulation systems have been widely use to predict the provision of goods and services and to analyses the effect of changing forest policies or even the impacts of climate change (Pasalodos-Tato et al., 2013). In this special issue Ray et al present a simulation system to assess policy implementation targets for Scotland's National Forest Estate under climate change conditions. Similarly, Zengin et al. uses simulation to assess the impact of policies promoting carbon sequestration and how this can affect levels of wood production. On the other hand, Kavaliuskas et al. uses scenario simulation to analyze the provision of timber under different contextual scenarios. Mustapha et al. apply a scenario analysis

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approach to analyze how techno-economic cost components of a novel forest-based biofuel production technology affect optimal allocation of biofuel production capacity in the Nordic countries at a regional level. Another example of the use of scenario analysis was presented by Eggers et al. where several scenarios were constructed to assess the consequences of various management options on different aspects of sustainable forest management using a forestry decision support system. They combined the use of scenarios with multi-criteria decision analysis.

3. Behavior models, agent frameworks and social networks

According to Yousefpour et al. (2017), the continuous flows of information arriving to l decision makers, affect their beliefs and expectations about scenarios such as climate change. In this context, behavioral decision research has started to investigate how forest owners relate to new knowledge, how they form and change perceptions, and how this affects their decision-making behavior (Blennow et al., 2012, 2016). Trubins et al. and Sotirov et al. build from this experience to discuss behavior models and agent frameworks so that policy makers are made aware of scenarios' behavioral assumptions and implications and may thus develop effective forest policies. Specifically, Trubins et al. presents an approach that uses a behavioral matrix to facilitate the definition and communication of behavioral assumptions, primarily in DSS-based forest scenario modelling, while Sotirov et al. develop an interdisciplinary agent-based framework for studying the provision of forest ecosystem goods and services (ES) at the landscape level. They discuss how theory-driven and evidence-based behavioral models in combination with forest owner and forest management insights can be used to analyze forest management behavior and responsiveness to policy and socioeconomic developments. For this purpose, they combine forest owner types and their behavioral models with forest decision support systems (DSS). On the other hand, Lovrik et al. focused on the usage of social influence network theory and models of network dynamics to assess how the interpersonal influence and inter-organizational power relations have affected forest policy decisions.

4. Multiple criteria methods and decision support systems

Addressing sustainability concerns when managing forest ecosystems is a complex task that requires the integration of diverse data, information, models, and methods as well as of concerns of different decision makers and/or policy makers. In this context, multicriteria methods have been successfully used to address multi-objective problems when multi-stakeholders are involved (e.g. Borges et al., 2014b). Decision support systems have been proved to be an effective tool to facilitate solving these problems (Garcia-Gonzalo et al., 2015).

Huber et al. and Alvarez-Miranda et al. present two multicriteria approaches to develop efficient forest management plans when dealing with multiple-objectives. Huber introduces a knowledge-based expert model for supporting non-wood forest products (NWFP) management. The objective is to depict regional production and business potentials of NWFPs, explicitly addressing different environmental and socio-economic contexts. For this purpose, they use multi-criteria analysis methods where preferences are elicited in an iterative form from stakeholders and experts. Álvarez-Miranda et al. present a multi-objective optimization model where timber production in addition to erosion and carbon sequestration are analyzed under uncertainty of forest growth and market prices. The proposed framework is embedded within a decision support system to project the effects of different stand-level management alternatives for several stands and optimize their allocation according to efficient trade-offs among the three criteria.

One of the shortcomings of the use of decision support systems in forest policy analysis is that often they are not developed specifically for the needs of the policy makers (Gordon et al., 2014; Linkevicious et al.). In this special issue, some DSSs are presented that have been used/developed in the framework of policy analysis. For example, Nobre et al. present a conceptual model to develop effective and accountable restoration projects. Based on action learning principles and recommendations from a literature review, they developed a Forest Management Decisions Support System (FMDSS) that embeds adaptive management strategies and the existence of an auto-updatable knowledge base. The result is a conceptual model that can be generalizable and applicable beyond the realms of the FMDSS. Karkainen et al. used a DSS to analyze the impacts of political decisions concerning land use constraints on potential raw material procurement by the saw mill industry in different operational environments. Similarly, Griess et al. used a DSS to assist policy making by providing a comprehensive assessment of consequences associated with management alternatives, to ensure that long term targets are met.

Athaniasiadis et al. presents “e-praxis”, a Web-based Decision Support System (DSS), to assist the land Characterization Acts (CA) issuing process, performed by the Greek Forest Service (GFS). The objective is to assist in the process of characterization of specific or wider land areas, based on the applicable legislation and the fundamental principles of Forest Ecology utilizing the “Rule-Based Reasoning” technique for the design and implementation of the decision model.

5. Discussion and conclusions

The use of decision support tools to address decision-making in the framework of forest resource management planning has expanded substantially over the past decades (Borges et al., 2014a; Vacik et al., 2015; Marto et al., 2018; Nordström et al., 2019). Many of these tools integrate spatial and non-spatial data information systems, projection tools (e.g. forest growth and yield models) and operations research techniques. The integrated functionality of these tools has contributed to increase the efficiency and the effectiveness of forest management planning (e.g. Reynolds et al., 2008) and this is acknowledged by stakeholders (Pastorella et al., 2016). In addition, there is a high potential for these tools to support forest policy analysis research since they can provide information and insights on the effect of different policies on the development of forests and their provision of ecosystem services (e.g. Menzel et al., 2012). Yet, while many decision-support (DS) tools (i.e. models, methods and decision support systems) have been developed to address forest management planning problems in Europe, the experience of using these tools to support forest policy processes remains limited (Linkevicius et al.).

This special issue provides examples of the use of different tools and techniques, such as: i) simulation and scenario analysis, ii) behavior models, agent frameworks and social networks and iii) multiple criteria methods and decision support systems, and discusses their use to support policy analysis. In addition, it provides insights to understand the potential of DS tools to enhance forest policy analysis processes.

We hope that this special issue does meet the challenge to provide a learned overview of capacities in the use of forestry decision support tools for integrated policy analysis and may thus become a useful reference tool to students, researchers, and forest practitioners interested in this field.

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